UNIT – 1 CONCEPTS OF MOBILE COMPUTING

1. What is Mobile Computing?

Mobile Computing is a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device without having to be connected to a fixed physical link. The main concept involves −

- Mobile communication
- Mobile hardware
- Mobile software

Mobile communication

The mobile communication in this case, refers to the infrastructure put in place to ensure that seamless and reliable communication goes on. These would include devices such as protocols, services, bandwidth, and portals necessary to facilitate and support the stated services. The data format is also defined at this stage. This ensures that there is no collision with other existing systems which offer the same service.

Since the media is unguided/unbounded, the overlaying infrastructure is basically radio wave-oriented. That is, the signals are carried over the air to intended devices that are capable of receiving and sending similar kinds of signals.

Mobile Hardware

Mobile hardware includes mobile devices or device components that receive or access the service of mobility. They would range from portable laptops, smartphones, tablet Pc's, Personal Digital Assistants.

These devices will have a receptor medium that is capable of sensing and receiving signals. These devices are configured to operate in full- duplex, whereby they are capable of sending and receiving signals at the same time. They don't have to wait until one device has finished communicating for the other device to initiate communications.

Above mentioned devices use an existing and established network to operate on. In most cases, it would be a wireless network.

Mobile software

Mobile software is the actual program that runs on the mobile hardware. It deals with the characteristics and requirements of mobile applications. This is the engine of the mobile device. In other terms, it is the operating system of the appliance. It's the essential component that operates the mobile device.

Since portability is the main factor, this type of computing ensures that users are not tied or pinned to a single physical location, but are able to operate from anywhere. It incorporates all aspects of wireless communications.

2. Difference between Fixed and Wireless Networks in Mobile Computing:

The differences between Fixed and Wireless networks can be distinguished as that the wireless networks do not require any cables to make a physical connection with the device. It is easily assessable because it is a shared medium. On the other hand, in the case of fixed networks, a physical configuration of devices is mandatory to perform data transmission. In this medium, you have to connect every new device separately and physically to the

network. Let's consider and make a comparison between these two technologies used in mobile computing.

The following table specifies the main differences between the Fixed and Wireless Networks in mobile computing technology:

Wireless Networks	Fixed Networks
There is no requirement of any physical configuration in the wireless network.	In Fixed Networks, a physical configuration is required in any condition.
The data loss rate is high in Wireless Networks.	In Fixed Networks, a perfect link is established between the devices, so; the data loss rate is very low.
In Wireless Networks, the data transmission rate is comparatively low, so it provides less speed.	In Fixed Networks, the rate of data transmission is high, so it provides high speed.
Latency is high in Wireless Networks, which finally results in more delay.	There is no issue of latency in Fixed Networks because there is a perfect connection established between the devices that provide less delay.
The Wireless Networks may be hacked; that's why the security is always low in this type of network.	Fixed Networks connections are highly secured.

3. What is Multiplexing in Mobile Computing?

Multiplexing is a technique used in the area of electronics and signal processing. In mobile computing, telecommunications and computer networks, Multiplexing is a method that can be used to combine multiple analog or digital signals into one signal over a shared medium. The main aim of using this method is to share a scarce resource.

Example: You can see a real-life example of Multiplexing in the telecommunication field where several telephone calls may be carried using one wire. Multiplexing is also called as **muxing**.

Multiplexing is a technique that allows multiple simultaneous analogs or digital signal transmission across a single data link.

The main motive behind the development of Multiplexing is to provide simple and easy communication, proper resource sharing and its utilization. This is the best way to utilize and share a limited resource equally among multiple devices.

4. What is Modulation in Mobile Computing?

Modulation is a process of mixing signals with a sinusoid to produce a new form of signals. The newly produced signal has certain benefits over an un-modulated signal. Mixing of low-frequency signal with a high-frequency carrier signal is called Modulation.

In other words, you can say that "Modulation is the **process of converting one form of signals into another form of signals**." For example, Analog signals to Digital signals or Digital signals to Analog signals.

Modulation is also called **signal modulation**.

Example: Let's understand the concept of signal modulation by a simple example. Suppose an Analog transmission medium is available to transmit signals, but you have a digital signal that needs to be transmitted through this Analog medium. So, to complete this task, you have to convert the digital signal into an analog signal. This process of conversion of signals from one form to another form is called Modulation.

Need for Modulation/ Why Use Modulation?

The baseband or low-frequency signals are not such strong and compatible signals that can be used for direct transmission. To make these signals travel longer distances, we have to increase their strength by modulating them with a high-frequency carrier wave. This process doesn't affect the parameters of the modulating signal.

Modulation is used to make the message carrying signal strong to be transmitted over a long distance and establish a reliable communication. A high-frequency signal can travel up to a longer distance without getting affected by external disturbances. In Modulation, these high-frequency signals are used as a carrier signal to transmit the message signal. This process is called Modulation. In Modulation, the carrier signals' parameters are changed according to the instantaneous values of the modulating signal.

Another reason to modulate a signal is to allow a smaller antenna as we know that a low-frequency signal would need a huge antenna. An antenna needs to be about 1/10th the length of the wavelength of the signal to be efficient. Modulation converts the low-frequency signal into a much higher frequency signal, which has much smaller wavelengths and allows a smaller antenna.

5. Fundamentals of Spread Spectrum in Mobile Computing:

Spread spectrum is a technique used for wireless communications in telecommunication and radio communication. In this technique, the frequency of the transmitted signal, i.e., an electrical signal, electromagnetic signal, or acoustic signal, is deliberately varied and

generates a much greater bandwidth than the signal would have if its frequency were not varied.

In other words, "Spread Spectrum is a technique in which the transmitted signals of specific frequencies are varied slightly to obtain greater bandwidth as compared to initial bandwidth."

Now, spread spectrum technology is widely used in radio signals transmission because it can easily reduce noise and other signal issues.

Example of Spread Spectrum

Let's see an example to understand the concept of spread spectrum in wireless communication:

We know that a conventional wireless signal frequency is usually specified in megahertz **(MHz)** or gigahertz **(GHz).** It does not change with time (Sometimes it is exceptionally changed in the form of small, rapid fluctuations that generally occur due to modulation). Suppose you want to listen to FM stereo at frequency 104.8 MHz on your radio, and then once you set the frequency, the signal stays at 104.8 MHz. It does not go up to 105.1 MHz or down to 101.1 MHz. You see that your set digits on the radio's frequency dial stay the same at all times. The frequency of a conventional wireless signal is kept as constant to keep bandwidth within certain limits, and the signal can be easily located by someone who wants to retrieve the information.

6. Fundamentals of Bluetooth Technology in Mobile Computing:

Bluetooth technology is a high speed and low powered wireless technology designed to connect phones or other portable equipment for communication or file transmissions. This is based on mobile computing technology. Following is a list of some prominent features of Bluetooth technology:

- Bluetooth is also known as IEEE 802.15 standard or specification that uses low power radio communications to link phones, computers and other network devices over a short distance without using any type of connecting wires.
- As Bluetooth is an open wireless technology standard so, it is used to send or receive data to connected devices present across a certain distance using a band of 2.4 to 2.485 GHz.
- In Bluetooth technology, the wireless signals transmit data and files over a short distance, typically up to 30 feet or 10 meters.

- Bluetooth technology was developed by a group of 5 companies known as Special Interest Group formed in 1998. The companies are Ericsson, Intel, Nokia, IBM, and Toshiba.
- The range of Bluetooth technology for data exchange was up to 10 meters in older versions of devices, but the latest version of Bluetooth technology i.e., Bluetooth 5.0, can exchange data in the range of about 40-400 meters.
- The average speed of data transmission in Bluetooth technology was around 1 Mbps in the very first version. The second version was 2.0+ EDR, which provided the data rate speed of 3Mbps. The third was 3.0+HS, which provided the speed of 24 Mbps. The latest version of this technology is 5.0.

History of Bluetooth

There is an amazing story behind the history of Bluetooth technology. The Bluetooth wireless technology was named after a Danish King named **Harald Blatand**. His last name means "Bluetooth" in English. The name "Bluetooth" was awarded to this technology because the Danish King named Harald Blatand was united the Denmark and Norway, same as Bluetooth wireless technology is used to unite two disparate devices for communication or data transmission.

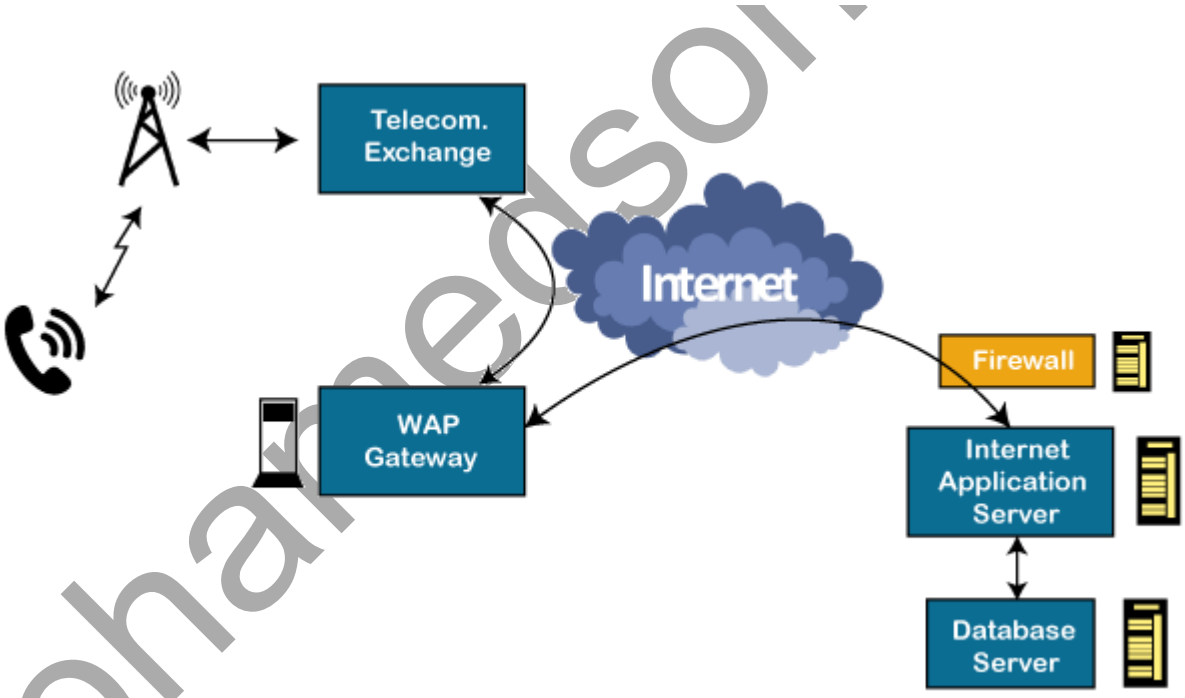
Ericsson Mobile Communications started the development of Bluetooth technology in 1994. The main motive behind the development of this amazing technology was to find an alternative to the use of cables for communication between mobile phones and other devices. In 1998, 4 big companies of that time named Ericsson, IBM, Nokia and Toshiba formed the Bluetooth Special Interest Group (SIG), which published the 1st version of Bluetooth technology in 1999. After that, four versions have been released. The latest version of this technology is Bluetooth 5.0.

7. Concepts of Wireless Application Protocol (WAP) in Mobile Computing:

Wireless Application Protocol or WAP is a programming model or an application environment and set of communication protocols based on the concept of the World Wide Web (WWW), and its hierarchical design is very much similar to TCP/IP protocol stack design. See the most prominent features of Wireless Application Protocol or WAP in Mobile Computing:

- WAP is a De-Facto standard or a protocol designed for micro-browsers, and it enables the mobile devices to interact, exchange and transmit information over the Internet.

- WAP is based upon the concept of the World Wide Web (WWW), and the backend functioning also remains similar to WWW, but it uses the markup language Wireless Markup Language (WML) to access the WAP services while WWW uses HTML as a markup language. WML is defined as XML 1.0 application.
- In 1998, some giant IT companies such as Ericson, Motorola, Nokia and Unwired Planet founded the WAP Forum to standardize the various wireless technologies via protocols.
- After developing the WAP model, it was accepted as a wireless protocol globally capable of working on multiple wireless technologies such as mobile, printers, pagers, etc.
- In 2002, by the joint efforts of the various members of the WAP Forum, it was merged with various other forums of the industry and formed an alliance known as Open Mobile Alliance (OMA).
- WAP was opted as a De-Facto standard because of its ability to create web applications for mobile devices.



Working of Wireless Application Protocol or WAP Model:

The following steps define the working of Wireless Application Protocol or WAP Model:

- The WAP model consists of 3 levels known as Client, Gateway and Origin Server.
- When a user opens the browser in his/her mobile device and selects a website that he/she wants to view, the mobile device sends the URL encoded request via a network to a WAP gateway using WAP protocol.

- The request he/she sends via mobile to WAP gateway is called as encoding request.
- The sent encoding request is translated through WAP gateway and then forwarded in the form of a conventional HTTP URL request over the Internet.
- When the request reaches a specified Web server, the server processes the request just as it would handle any other request and sends the response back to the mobile device through WAP gateway.

Applications of Wireless Application Protocol (WAP):

The following are some most used applications of Wireless Application Protocol or WAP:

- WAP facilitates you to access the Internet from your mobile devices.
- You can play games on mobile devices over wireless devices.
- It facilitates you to access E-mails over the mobile Internet.
- Mobile hand-sets can be used to access timesheets and fill expenses claims.
- Online mobile banking is very popular nowadays.
- It can also be used in multiple Internet-based services such as geographical location, Weather forecasting, Flight information, Movie & cinema information, Traffic updates etc. All are possible due to WAP technology.

8. Concepts of Mobile Agents in Mobile Computing:

In Mobile Computing, Mobile Agents are the composition of computer software and data that can autonomously move from one computer to another computer and continue its execution on the destination computer.

In other words, you can say that An Mobile Agent is an autonomous program that is capable of moving from host to host in a network and interact with resources and other agents. In this process, the chance of data loss is scarce because the state of the running program is saved and then transported to the new host. It allows the program to continue execution from where it left off before migration. The most significant advantage of mobile agents is the possibility of moving complex processing functions to the location where you have enormous amounts of data and that have to be processed.

Mobile Agents are also called as transportable agents. They are classified into two types:

- **Mobile Agents with pre-defined path:** They have a static migration path.
- **Mobile Agents with undefined path i.e., Roamer:** They have dynamic migration paths. The mobile agents choose their path according to the present network condition.

Features of Mobile Agents:

The mobile agents are autonomous with intelligence, social ability, learning, and the most important feature is their mobility. They are independent in nature, self-driven and do not require a corresponding node for communication. They can work efficiently even after the user gets disconnected from the network.

Intelligence

Mobile Agents are capable of learning and searching for knowledge about their domain. That's why they are called intelligent agents because they possess a degree of domain knowledge. They can also transport their state from one environment to another without disturbing the previous holding data and be capable of performing appropriately in the new environment.

Autonomous

The Mobile Agents are Autonomous. It means the agents are not only motivated by the outside actions initiated by the users or system but also they have internal events that decided their performance and behavior. The mobile agents can also take an autonomous decision while selecting a node.

Mobility

Mobile Agents contain some degree of mobility. The agent is not limited to its home node only. They can migrate from one node to another and can carry out tasks along with them. This feature distributes the processing and balancing of the load. Another benefit of this capability is that when the user goes offline, the agents will still keep functioning.

Communicative

Mobile Agents can communicate effectively with other agents, users and systems. The mobile agents use a communication language for inter-agent communication.

Applications of Mobile Agents:

Mobile agents are used in the following applications:

- Mobile Agents are applied in a wide range of domains such as E-commerce, traffic control, network management, robotics, data-intensive applications etc.
- They are also used in grid computing, parallel computing, distributed computing and mobile computing etc.

9 Introduction of Android:

Android is an open source and Linux-based **Operating System** for mobile devices such as smartphones and tablet computers. Android was developed by the *Open Handset Alliance*, led by Google, and other companies.

Android offers a unified approach to application development for mobile devices which means developers need only develop for Android, and their applications should be able to run on different devices powered by Android.

The first beta version of the Android Software Development Kit (SDK) was released by Google in 2007 where as the first commercial version, Android 1.0, was released in September 2008.

On June 27, 2012, at the Google I/O conference, Google announced the next Android version, 4.1 **Jelly Bean**. Jelly Bean is an incremental update, with the primary aim of improving the user interface, both in terms of functionality and performance.

The source code for Android is available under free and open source software licenses. Google publishes most of the code under the Apache License version 2.0 and the rest, Linux kernel changes, under the GNU General Public License version 2.

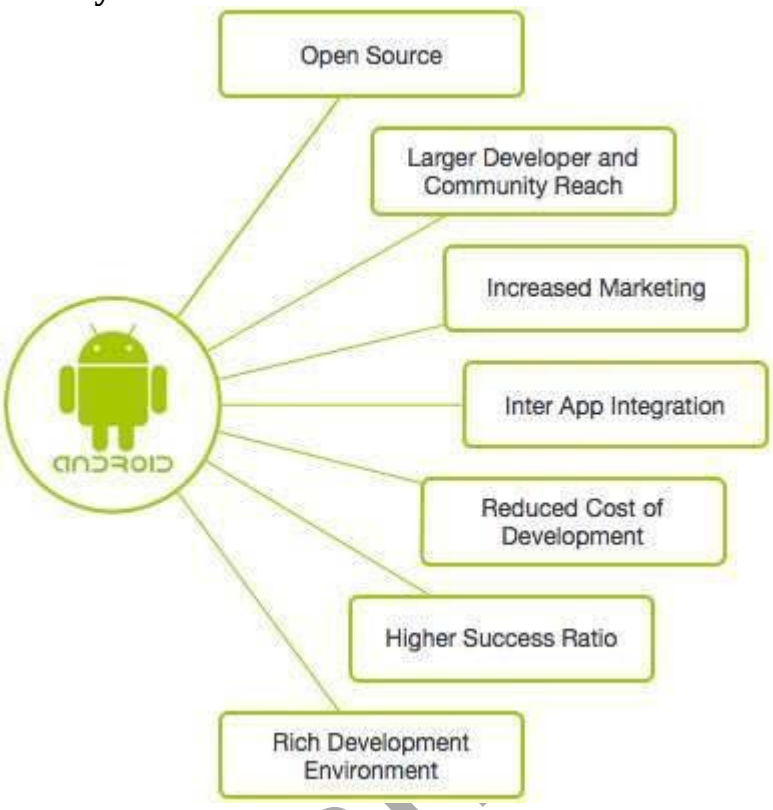
History of Android:

The code names of android ranges from A to N currently, such as Aestro, Blender, Cupcake, Donut, Eclair, Froyo, Gingerbread, Honeycomb, Ice Cream Sandwitch, Jelly Bean, KitKat, Lollipop and Marshmallow. Let's understand the android history in a sequence.

Sr.No.	Feature & Description
1	**Beautiful UI** Android OS basic screen provides a beautiful and intuitive user interface.
2	**Connectivity** GSM/EDGE, IDEN, CDMA, EV-DO, UMTS, Bluetooth, Wi-Fi, LTE, NFC and WiMAX.
3	**Storage** SQLite, a lightweight relational database, is used for data storage purposes.
4	**Media support** H.263, H.264, MPEG-4 SP, AMR, AMR-WB, AAC, HE-AAC, AAC 5.1, MP3, MIDI, Ogg Vorbis, WAV, JPEG, PNG, GIF, and BMP.
5	**Messaging** SMS and MMS
6	**Web browser** Based on the open-source WebKit layout engine, coupled with Chrome's V8 JavaScript engine supporting HTML5 and CSS3.
7	**Multi-touch** Android has native support for multi-touch which was initially made available in handsets such as the HTC Hero.
8	**Multi-tasking** User can jump from one task to another and same time various application can run simultaneously.
9	**Resizable widgets** Widgets are resizable, so users can expand them to show more content or shrink them to save space.
10	**Multi-Language** Supports single direction and bi-directional text.
11	**GCM** Google Cloud Messaging (GCM) is a service that lets developers send short message data to their users on Android devices, without needing a proprietary sync solution.

12	**Wi-Fi Direct** A technology that lets apps discover and pair directly, over a high-bandwidth peer-to-peer connection.
13	**Android Beam** A popular NFC-based technology that lets users instantly share, just by touching two NFC-enabled phones together.

Why Android?



Features of Android:

Android is a powerful operating system competing with Apple 4GS and supports great features. Few of them are listed below −

10 Concepts of API framework:

The Android platform provides Java framework APIs to expose the functionality of some of these native libraries to apps. For example, you can access OpenGL ES through the Android framework's Java OpenGL API to add support for drawing and manipulating 2D and 3D graphics in your app.

Java API Framework

The entire feature-set of the Android OS is available to you through APIs written in the Java language. These APIs form the building blocks you need to create Android apps by simplifying the reuse of core, modular system components and services, which include the following:

- A rich and extensible View System you can use to build an app's UI, including lists, grids, text boxes, buttons, and even an embeddable web browser
- A Resource Manager, providing access to non-code resources such as localized strings, graphics, and layout files
- A Notification Manager that enables all apps to display custom alerts in the status bar
- An Activity Manager that manages the lifecycle of apps and provides a common navigation back stack
- Content Providers that enable apps to access data from other apps, such as the Contacts app, or to share their own data

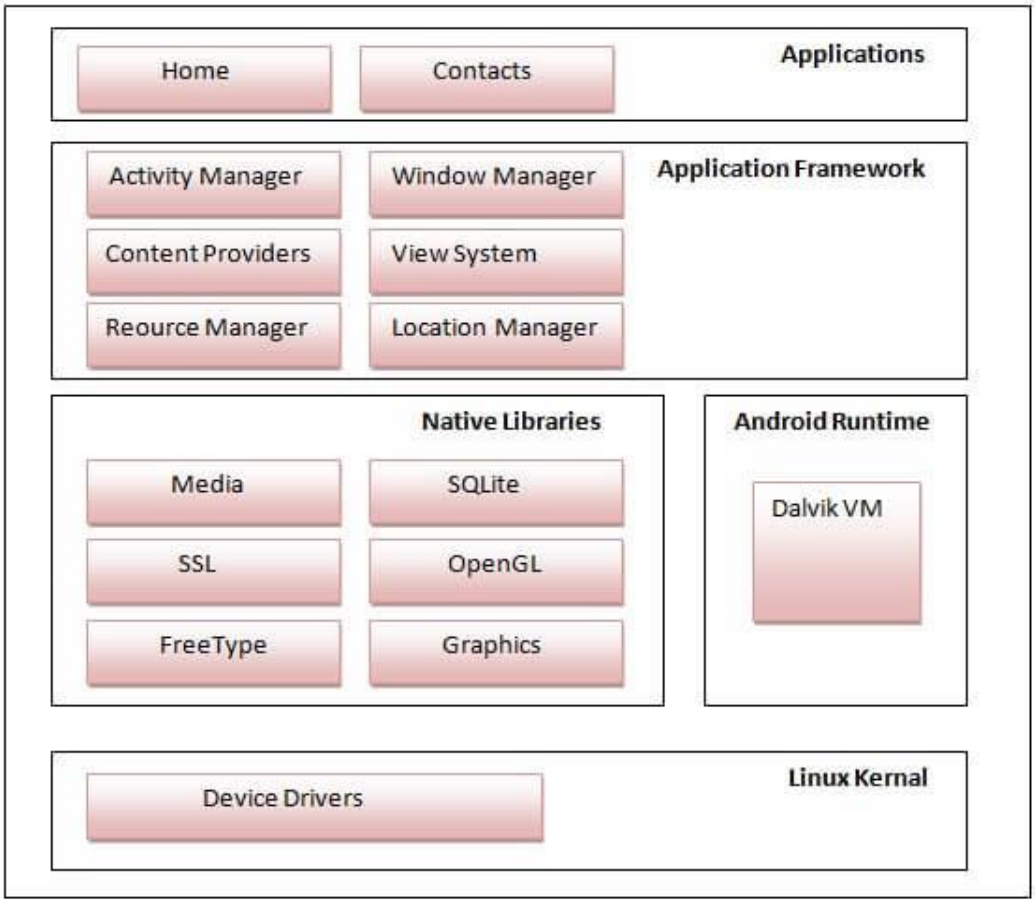
Developers have full access to the same framework APIs that Android system apps use.

11 Introduction of Android Architecture (Software Stack):

Android is an open source, Linux-based software stack created for a wide array of devices and form factors. The following diagram shows the major components of the Android platform. **Android Architecture** or **Android Software Stack** is categorized into five parts:

1. Linux Kernel
2. Native Libraries (Middleware),
3. Android Runtime
4. Application Framework
5. Applications

Let's see the Android Architecture first.



1) Linux Kernel:

It is the heart of android architecture that exists at the root of android architecture. **Linux kernel** is responsible for device drivers, power management, memory management, device management and resource access.

2) Native Libraries:

On the top of linux kernel, their are **Native libraries** such as WebKit, OpenGL, FreeType, SQLite, Media, C runtime library (libc) etc.

The WebKit library is responsible fJor browser support, SQLite is for database, FreeType for font support, Media for playing and recording audio and video formats.

3) Android Runtime

In android runtime, there are core libraries and DVM (Dalvik Virtual Machine) which is responsible to run android applicatJion. DVM is like JVM but it is optimized for mobile devices. It consumes less memory and provides fast performance.

4) Android Framework:

On the top of Native libraries and android runtime, there is android framework. Android framework includes **Android API's** such as UI (User Interface), telephony, resources, locations, Content Providers (data) and package managers. It provides a lot of classes and interfaces for android application development.

5) Applications:

On the top of android framework, there are applications. All applications such as home, contact, settings, games, browsers are using android framework that uses android runtime and libraries. Android runtime and native libraries are using linux kernal.